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Entitled: "Laminated Printed Circuit Board Fixture Assembly and Method"

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Title of the Invention

LAMINATED PRINTED CIRCUIT BOARD FIXTURE ASSEMBLY AND METHOD

Field of the Invention

The present invention relates to a printed circuit board fixture assembly and more particularly relates to a fixture for temporary securement of a printed circuit board during processing such as during wave soldering. More particularly, the present invention relates to a fixture assembly from multiple plates or substrates for masking a circuit board so that the leads of components are exposed while surface mounted components (SMTs), are protected or masked from the solder.

Printed circuit board assemblies (PCBA's) often carry surface mount technology components referred to as "SMTs" which are mounted and soldered to one or both sides of the board. The same printed circuit board assemblies also may contain plated through hole components (PTH's) on one or both sides of the PCB. During the wave the soldering procedure it is conventional practice to place a mask of some type over the surface on which soldering of the leads is to occur. The mask has openings which expose one or a plurality of the leads to be soldered. The mask will typically have recesses which receive the surface mounted components on the downwardly disposed surface of the board and shield these components during the wave soldering procedure.

Background of the Invention

Various devices for masking circuit boards during wave soldering may be found in the prior art. U.S. Patent No. 5,454,505 describes an apparatus for facilitating wave soldering treatment and other handling of circuit components during manufacture. The apparatus has a rigid frame symmetrical about a plane and defining an opening which traverses the frame intermediate a first side and second side. The apparatus further comprises a masking member affixed to the frame defining a plurality of apertures traversing the masking member to the opening in the frame. A holding device maintains the circuit components in an operational location in fixed relation with the masking member with the frame during wave soldering. Areas in the circuit component are substantially in registry with an aperture of the masking member when the circuit component is in the operational location. The walls about the apertures have a ramp for effecting solder flow during wave solder treatment.

U.S. Patent No. 4,739,919 discloses a soldering mask for soldering the leads of leaded components to a circuit pattern on a surface of the circuit board having surface mounted components already soldered to the circuit pattern on that surface. The mask comprises a flat metal plate having a recess in the top surface with a plate for reception of the circuit board. Cavities in the bottom surface of the recess house the surface mounted components. Openings through the plate from the bottom surface of the recess permit passage of leads and also permit access by the solder to the solder leads of the circuit pattern.

While the above patents and other similar devices in the prior art facilitate masking of circuit boards for wave soldering, there nevertheless exists a need for a fixture which can be economically manufactured without the necessary expensive machining and milling

operations. There further exists a need for a more versatile, less expensive fixture having components which can be used with various PCBA's.

Summary of the Invention

Briefly, the present invention provides a fixture or holding assembly that is assembled from a plurality of individual substrates or plates that have been fabricated to accommodate the requirements of a particular PCBA. The first or top plate is configured having a cut-out to conform to the perimeter of the PCBA and to properly align the PCBA to be processed. An intermediate or middle plate has cutouts of the various sizes and shapes to accommodate various SMT devices that are mounted on the surface of the PCBA that will be downwardly disposed during wave soldering. This downwardly disposed surface of the PCBA is typically referred to as the secondary side. The intermediate plate will contain cutouts of various sizes which become protective cavities once the bottom or lower plate is attached to the bottom or secondary side of the intermediate plate. The intermediate plate may also contain apertures of various sizes to accommodate the leads of PTH devices mounted on the upper surface of the PCBA which is typically referred to as the primary side. These cutouts will align and register with similar apertures in the bottom most plate to allow leads to pass through both the intermediate and bottom plates.

The intermediate plate is of the appropriate thickness to accommodate the height of the SMT and PTH devices mounted on the secondary side so that when the bottom plate is attached, the cut-outs in the intermediate plate define protective cavities and recesses. The bottom plate is secured to the bottom surface of the intermediate plate and has apertures of

various shapes that align with similar cut-outs to accommodate the passage of the PTH devices. Since the lower plate defines apertures only for the leads of the PTH devices on the primary side of the PCBA, the addition of the bottom plate shields and protects the bodies of the SMT and PTH devices that are mounted on the secondary side of the PCBA. An additional, optional plate termed a "weighting plate" may also be provided which will hold the PCBA flat against the surface of the intermediate plate. The optional weighting plate has locating holes which registers with alignment pins or posts. The weighting plate has adjustable fasteners inserted to appropriate depths so that the weighting plate applies a downward force against the PCBA through the depending fasteners. Preferably the fasteners are threaded members of nylon or similar material which will contact the PCBA only in unpopulated areas.

Brief Description of the Drawings

The above and other objects and advantages will become more apparent from the following description, claims and drawings in which:

Figure 1 is a perspective view of the multi-plate holding fixture assembly for PCBA's according to the present invention;

Figure 2 is a plan view of the uppermost plate of the multi-plate fixture;

Figure 3 is a plan view of a representative intermediate plate;

Figure 4 is a plan view of a representative bottom plate;

Figure 5 is a cross-sectional view of a representative PCBA mounted within the fixture assembly ready for processing by a wave soldering process;

Figure 6 is a cross-sectional view of a representative fixture including the addition of a weighting plate for maintaining the PCBA in a flat position within the fixture; and

Figure 7 is a cross-sectional view showing an alternate embodiment of the lower plate having a laminate construction to facilitate solder access to the component leads.

Detailed Description of the Drawings

Turning now to the drawings, Figures 1 to 5 illustrate an embodiment of the fixture assembly of the present invention which is generally indicated by the numeral 10. The fixture consists of an assembly comprised of multiple plates 12, 14, and 16. The upper plate 12 is shown in Figure 2 and is a frame-like structure having an outer periphery 20 and an inner periphery 18 which is as shown as being generally rectangular. The dimensions and configuration of the plate 12 may vary in accordance with the PCBA which is to be processed. The dimensions of the inner periphery 18 are sized and configured to closely conform to the perimeter of the PCBA and to properly align the PCBA in the fixture. The upper plate 12 can be made of various materials such as titanium, stainless steel or aluminum, however materials such as fiberglass and similar glass-based composite materials are preferred. All of the plates or substrates which make up the fixture may be of the same material or each plate can be made of a different material. Similarly each plate may be fabricated from several lamina joined to the desired thickness. The cut-out 18 in the plate 12 can be formed by any suitable operation such as cutting, machining, milling as laser cutting.

The next subjacent or intermediate plate 14 in the assembly is generally indicated by the numeral 14. As seen in Figure 3, the plate 14 has an outer periphery 24 which conforms to

the outer periphery 20 of the upper plate 12. Plate 14 is provided with a plurality of cut-outs indicated as 32, 34 and 36. Cut-outs 32 are sized and shaped to accommodate SMT devices that may be mounted on the secondary or lower surface of the PCBA that will be in contact with plate 14. The downwardly disposed surface of the PCBA is typically referred to as secondary bottom side.

The cut-outs 32, shown as round for purposes of this description, may by any geometric shape. As will become apparent hereafter, with the installation of the bottom plate 16, these cut-outs 32 will define protective cavities, as best seen in Figures 1 and 5, that will protect the SMTs.

In addition, the plate 20 is provided with a plurality of areas designated by numeral 34, which are configured to receive PTH components on the secondary side of the PCBA to be processed. In addition, a plurality of cut-outs 36, which are various sizes and shapes to accommodate the leads of PTH devices mounted on the top or primary side of the PCBA. These cut-outs or apertures 36 will align or register with identical or similarly shaped apertures 46 in the bottom plate 16 to allow the leads to pass through both the intermediate and bottom plates for soldering. The shape of these apertures 36, 46 may conform to the shape of only a single lead or may be various shapes to configure to extend around a plurality or group of adjacent leads.

Plate 16 is the lower most plate and is secured to the intermediate plate mechanically or by adhesive or bonding methods. As mentioned above, the lower plate 16 has apertures of various sizes and shapes 46 that align with the cut-outs in plate 14 to accommodate the passage of PTH leads. While the through hole cut-outs or apertures in the lower plate 16 may

be identical in size and shape to those of the intermediate plate 14, it is preferred that they be configured as shown in detail in Figure 1 to facilitate the flow of solder to the leads during the wave soldering operation. The lower plate 16 may be a laminate structure fabricated from several thinner plates 16A, 16B, as seen in Figure 7 with the aperture 46B in plate 16B being larger than aperture 46A in the plate 16A so the result is a through hole 46 of upwardly decreasing size. The plates are assembled as a unitary structure as shown in Figure 1. The individual plates may be of the same or similar material. The plates 16A, 16B may be fastened or secured together by any conventional means such as use of stainless steel fasteners 48.

A significant advantage of the multi-plate structure of the fixture assembly is that machining, milling or cutting out the various areas is facilitated and more easily accomplished since in each substrate the cut-outs extend entirely through the individual plate. It is not necessary for complicated milling or CNC operations be performed in order to form cavities or recesses of different depths. Further, the individual components may be used in connection with the processing of PCBAs of various configuration. For example, the uppermost plate 20 might be used in connection with PCBAs having various components if the PCBAs have the same outer dimensional configuration. In this case, it will be necessary only to fabricate the intermediate and the bottom plates resulting in a savings economy of manufacture. The assembly and disassembly of a fixture is facilitated by use of fasteners such as screws. Further each plate may itself be a composite structure of several laminates. For example, if plate 14 is required to be .060" in thickness, two .030" thick plates may be secured together to achieve the desired thickness. In some instances processing PCBAs having only through

holes, the intermediate plate 14 can be eliminated and, in which case, the fixture assembly would comprise only upper plate 12 and the lower plate 16 to mask the through holes.

It is important that during the wave soldering operation that the PCBA be maintained in a firm, planar condition so that the leads are properly soldered and that solder leakage through the lower plate does not occur. Referring to Figure 6, it may be desirable in some applications to utilize a weighting plate which is designated by the numeral 70. The plate 70 will serve as a means to hold the PCBA flat against the intermediate plate 14. The plate 70 will be received over pins 80 that project upwardly from the upper plate 12. The weighting plate 70 is provided with a plurality of threaded holes 75 which correspond in location to unpopulated flat areas in the PCBA to be processed. At least selected of the threaded holes 75 will receive a threaded spacer 78, such as nylon screws, which can be adjusted to the required length extending from the lower surface of the plate 70. The plate, which serves as a weighting plate, is preferably suitably of a heavy material such as steel or stainless steel. The plate 70 is positioned over the alignment posts 80 and the spacers 78 are adjusted to contact the upper surface of the PCBA applying downward pressure to maintain the PCBA in a flat planar position firmly against the upper surface of the intermediate plate.

It will be obvious to those skilled in the art to make various changes, alterations and modifications to the invention described herein. To the extent such changes, alterations and modifications do not depart from the spirit and scope of the appended claims. They are intended to be encompassed therein.

I CLAIM: